

Application News

Hardness Measurement of Flexible Cellular Polymeric Materials (Foam Rubber) Based on ISO 2439

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User Benefits

- ◆ The hardness of foam rubber can be quantitatively evaluated using a test method A compliant with ISO 2439.
- ◆ Using the inter-jig distance function and GL correction, the height of foam rubber specimen can be automatically obtained.
- ◆ By using a foam rubber compressive test jig with air-vent holes, the effect of air inside the foam rubber can be reduced.

Introduction

Soft foam materials (foam rubber), which are widely used in furniture and automotive cushions, provide comfortable seating and sleeping conditions and greatly improve quality of life. In automotive applications, they also contribute to reducing fatigue during long periods of driving and to ensuring safety in seats and interior components. Thus, foam rubber is an important material closely related to daily life, and its performance directly affects user comfort and safety. In particular, hardness is a key physical property that influences both the comfort and durability of foam rubber, making its evaluation essential in product design and quality control. ISO 2439 defines five methods for measuring foam rubber hardness (Methods A, B, C, D, and E). In this Application News, a test method based on Method A of ISO 2439 is introduced using a precision universal testing machine, AGX™-V2, together with a foam rubber compression test jig. The hardness of three types of foam rubber test specimens was measured, and the corresponding measurement results are described.

Apparatus

The test apparatus configuration, the AGX-V2, and test apparatus are shown in Table 1, Fig. 1, and Fig. 2, respectively. A foam rubber compressive test jig was used as the test jig. This jig consists of an upper compression plate with a diameter of 200 mm and a 400 mm × 400 mm lower compression plate.

Because foam rubber has a cellular structure, the internal air pressure increases during compression when the trapped air is unable to escape. This air pressure increase affects the deformation behavior of the foam rubber and causes the measurement of the test force to be higher than the actual hardness. Therefore, the lower compression plate has multiple air-vent holes to reduce this effect on the test results, allowing for accurate hardness evaluation.

Table 1 Test Apparatus

Testing Machine:	Precision Universal Testing Machine AGX-100kNV2
Load Cell Capacity:	1 kN
Software:	TRAPEZIUM™X-V (Control)
Jig:	Foam Rubber Compressive Testing Jig



Fig. 1 Precision Universal Testing Machine AGX™-V2

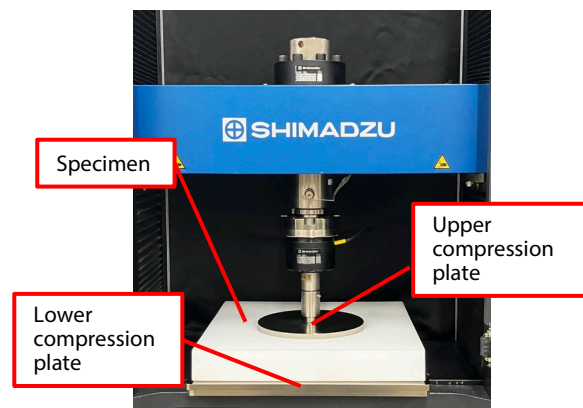


Fig. 2 Test Apparatus

Foam Rubber Specimen

The specimens used in this application are shown in Fig. 3. ISO 2439 specifies that the specimen shall be cut to obtain a standard-size square of side length 380 mm, with a thickness of 50 mm. In this application, three types of urethane foam rubber (ESC, EFF, EMB) were made satisfying this dimensional requirement.



Fig. 3 Urethane Foam Specimens

■ Test Method

In ISO 2439 Method A, it is specified that the hardness should be obtained by the following procedure.

1. Apply a force of 5 N to the selected test area and measure the thickness of the specimen. This value is the point of zero indentation.
2. Indent the specimen at a rate of 100 ± 20 mm/min, to produce an indentation of 70 ± 2.5 % of the thickness.
3. Release the force at the same rate.
4. Repeat this loading and unloading twice more. (The procedure 1 to 4 is defined as preliminary indentation)
5. Immediately after the preliminary indentation, indent the specimen by 40 ± 1 % of its thickness.
6. Hold the deflection for a period of 30 ± 1 sec, note the corresponding force. It is known as the indentation hardness index.

The procedure above can be performed using TRAPEZIUMX-V's control mode. By using both the inter-jig distance function and GL correction, the specimen thickness described in procedure 1 can be automatically obtained.

The test force noted in procedure 6 can be measured by one of the data processing items "GetData" in TRAPEZIUMX-V. By setting this item, the force when the hold operation ends can be automatically obtained.

■ Test Result

The test results are shown in Table 2 and Fig. 4.

Specimen	Indentation Hardness Index (N)
EMB	208
ECS	140
EFF	62

From Table 2, EMB has the largest indentation hardness index of the three and EFF has the lowest.

As shown in Fig. 4, the test force decreases from the start of hold to the end of hold. This behavior is attributed to stress relaxation of the foam rubber specimens.

■ Conclusion

In this application, compression tests to three types of urethane foam specimens were performed using the AGX-V2 and foam rubber compressive test jig. Through these tests, each sample's indentation hardness index was obtained.

By using the inter-jig distance function and GL correction, the height of foam rubber specimen can be automatically obtained. This measurement can be expected to be applied to quantitative evaluation and quality control of foam rubber products.

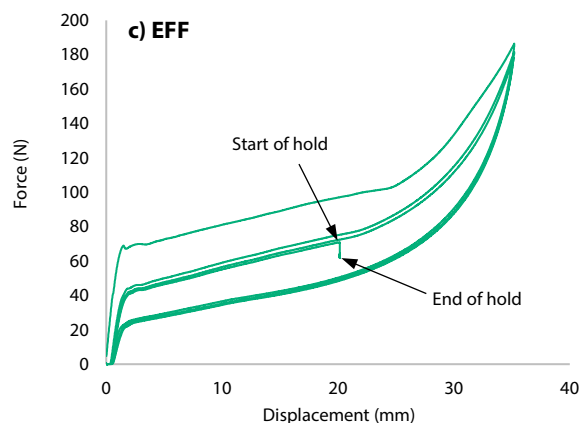
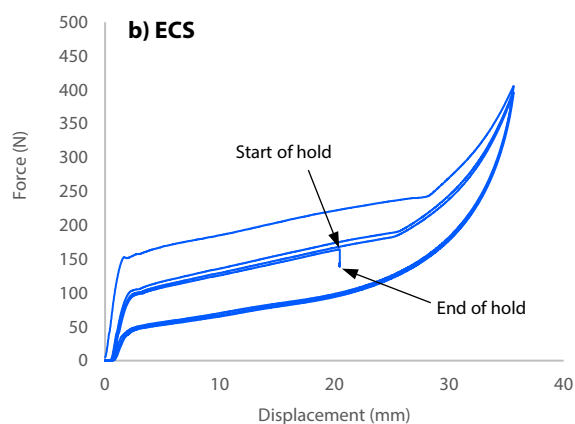
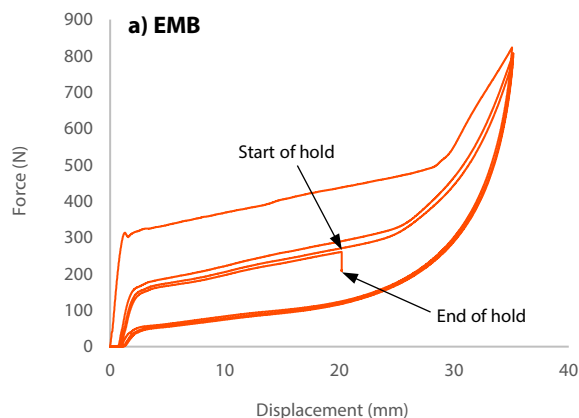


Fig. 4 Test Result a) EMB, b) ECS, c) EFF

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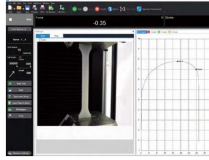
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